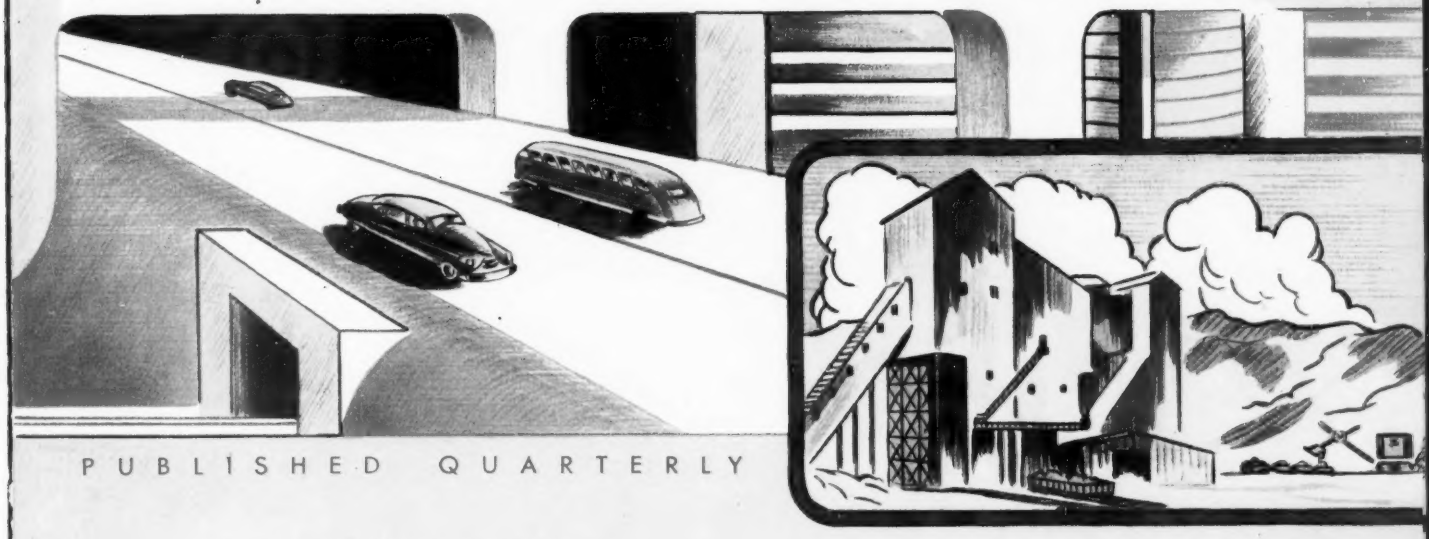
The CRUSHED STONE JOURNAL



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The Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

J. R. BOYD, Editor

Contents

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THE CONVENTION AND EXPOSITION ALL UNDER ONE ROOF

THE
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WASHINGTON, D. C.

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The Five Basic Issues in Highway Legislation[1]

By HONORABLE ALBERT GORE

U. S. Senator from Tennessee
Chairman, Senate Subcommittee on Roads
Washington, D. C.

WITH the exception of measures for prosecution of war, I cannot recall during my seventeen years in the Congress any major legislative proposals which have attracted such widespread support as have proposals for an accelerated highway program. Despite such support, however, we do not yet have legislation to provide the nation with the highways it needs and must have. A great deal has been said and written about the highway problem. The need for adequate highways has been dramatized; never before has the public been so highway conscious. In so far as public opinion is concerned, the time is ripe for far-reaching highway legislation.

Usually any speech on highway legislation begins with a discussion of the need for adequate highways, but I believe I can safely omit that today. You are aware, as I am, of the appalling cost of inadequate highways. You struggle day by day with the problems of your own highway budgets. Anyone who ventures on our highways sees abundant evidence in support of the prediction of 81 million automobiles by 1965. No one can ignore the headlines in our papers telling the tragic story of the daily slaughter of our people on the highways.

The economic aspects of roads, good or poor, cannot be ignored. In an economy so closely tied to highway transportation, the economic cost of poor roads is incalculable.

Everyone agrees that we need an accelerated highway improvement program. I would like to use the time allotted to me today, to discuss the various legislative proposals advanced in the Congress this year and the prospects of completing legislative action during the second session of the 84th Congress.

No one can say that the failure of Congress to pass the highway bill this year was due to the devotion of insufficient time and attention to the problem. The Public Works Committee of the Senate conducted the most exhaustive investigation ever undertaken on highway legislation. Further exhaustive hearings were held by the Public Works Committee of the House.

I have heard it said that the three bills seriously considered by the Congress—one advocated by the Administration, one passed by the Senate, and one recommended by the House Public Works Committee—all had the same objective and that they differed only in their method of financing. Some have characterized the Administration Bill as a "pay-as-you-use" plan. H.R. 7474, recommended by the House Committee, has sometimes been referred to as a "pay-as-you-go" bill. And some have described the bill passed by the Senate as one having no financing plan at all. Such characterizations of the three are misleading. At best, such descriptions constitute a dangerous over-simplification. In the first place, in some respects, the so-called differences in financing are more apparent than real. In the final analysis, under each plan the roads would be paid for out of the general funds of the United States Treasury. In the second place, the three bills pose fundamental differences in approach entirely apart from the question of financing.

It seems to me that there are five basic issues involved in highway legislation of such magnitude. I list them though not necessarily in the order of their importance.

[1] Presented at the American Road Builders' Association National Highway Conference of County Engineers and Officials, Gatlinburg, Tennessee, Tuesday, September 13, 1955

First, Congress must decide the scope of the program—how far and how fast we shall go.

Second, there must be a fair division of funds among the various segments of our federal-aid system.

Third, there must be an equitable formula for the apportionment of federal funds to the various states.

Fourth, there must be provisions for administration of the program and control of expenditures.

And *fifth,* there is the question of paying for the roads we build.

Any analysis or comparison of the three legislative proposals must take into consideration each of these five points.

I would like to discuss or compare the three bills, pointing out how they differ. If you detect in my remarks a hint now and then which indicates that I favor the bill passed by the Senate, you may be justified in assuming that is the one I like best—not only because I sponsored it in the Senate, but because I think it is based upon the soundest approach and that it alone embodies a balanced highway program.

I think it fair to say that from the standpoint of the amounts of federal money involved, the three bills are roughly comparable. Right at the beginning there was a lot of confusion generated by the phrases "Grand Plan" and "101 Billion Dollar Plan". Whether by design or inadvertence, the impression was allowed to get abroad that the Administration Bill would provide expenditures of 101 billion dollars to build all of our highways to a state of adequacy within ten years. Actually, the Administration Bill did not nearly approach this figure. It proposed the expenditure of 25 billion dollars of federal money, all of which would be spent on the Interstate System. In addition the Administration indicated an intention to support authorizations of $600,000,000 a year for use on all other federal-aid roads. If effectuated, this would have provided a total of 31 billion dollars in federal funds during the next 10 years. In order to implement the so-called "Grand Plan," states and local governments would have to raise more than 70 billion dollars within the next ten years. This would be just about equivalent to doubling what they are doing now. No suggestion was made as to how this was to be accomplished and I know of no one who seriously believed it would or could be done.

In terms of the total federal outlay in dollars, the Administration Bill contemplated 31 billion dollars in ten years. The Senate Bill provided authorizations of 12 1/4 billion dollars on federal-aid roads in five years. A second five-year installment, as contemplated in the Senate Bill, would bring the total to 26 3/4 billion dollars in ten years. The House Bill would have made available total authorizations of about 35 billion dollars on federal-aid roads extended over a period of thirteen years.

There are certain inescapable factors which limit the scope of any highway program. We cannot expand highways any faster than the construction industry can expand. Certainly, if we accelerate too fast, if we try to build on a crash basis, we will have inflation in highway construction, if not in our entire economy. A gradual acceleration makes sense if we want a dollar's worth of road for each dollar of money. This principle, in varying degrees, was recognized in all three bills. Progressive annual increases in authorizations were written into the Senate Bill and into the House Bill. Though no yearly schedule was written into the Administration Bill, those sponsoring it indicated to Congress that the amount provided by the bill would be spent in yearly increments, which would allow time for expansion into full-scale operation.

The second limiting factor is money itself. I acknowledge the extensive need for roads. I even think the big mythical figure of 101 billion dollars is conservative. But we cannot ignore the cost. I, for one, think that the need for highways must be considered along with, and balanced with, the need for other programs, such as schools and hospitals. It doesn't make sense to me to segregate the highway problem by excluding highway expenditures from the Budget and from the public debt. It doesn't make it any easier to pay for them. In my opinion, no financial legerdemain can isolate the highway expenditures or eliminate their impact upon our economy and upon the Treasury of the United States.

Now, a lot has been said about the merits of a ten-year bill, or a fifteen-year bill, or a five-year bill. Some have criticized the Senate Bill on the grounds that it does not complete the job. I realize that if the industry is to expand sufficiently to provide the facilities needed, there must be some assurance that these facilities will be used. In the Senate Public Works Committee we deliberated at length before deciding upon a five year authorization, rather than one for ten years or longer. I would like to tell you why we decided on five years.

I dare say that most of you in coming to Gatlin-

burg came at least part of the way by automobile. In all probability, you drove over highways whose designers thought, when they built them, that they had solved the highway problem in that particular locality for all time to come. But many of these highways are now obsolete. The philosophy behind the Administration Bill was that we could design and build *now* a system of interstate highways which would need no further improvements for thirty years. In the light of the history of the development of our country, I have doubt as to the wisdom of such a presumption. I think there are inherent disadvantages in tying ourselves to too rigid a program for too long a time. From time to time the program may need alteration to meet changing conditions. And, then Congress should frequently review the program. It was with these thoughts in mind that the Senate decided on a five year bill, including in the bill a strong statement declaring it to be the policy of the Congress to extend the program so as to complete the job. I know there are those who say that if a ten year bill were passed, Congress could always review it and change it, but if we limit the initial authorization to five years, the review is automatic. A five year authorization seemed to my committee a reasonable period of time for a vigorous start on a long-range program. So, when all factors are considered, if we add up the dollars involved, there isn't much difference in the scope of the three bills.

When we get to the second major point—the allocation of funds among the various segments of our federal-aid system—however, we get into more important aspects of differences in approach. We have more than 700,000 miles of highways in our federal-aid system. Some segments are more important than others, but all are important. Any program which ignores the needs of one segment in order to complete another, will not adequately or fairly serve the needs of the nation. Everyone recognizes that the federal government has a greater degree of responsibility for the Interstate System than for the remainder of the Primary System and the Secondary System, together with their urban connections. Each of the bills recognizes this responsibility—and, I think, appropriately so—by increasing the federal government's share of the cost of construction on these main trunkline highways. Both the Senate Bill and the House Bill specified that the federal government's share would be 90 per cent. The Administration Bill did not clearly specify any federal share, but it would probably average around 94 per cent. But here, on this question of emphasis—at least in so far as the Administration Bill is concerned—the similarity stopped.

The Administration Bill did more than recognize the paramount importance of the Interstate System. In effect, it allocated all new funds to the interstate system and ignored the Primary, Secondary, and Urban problem. For this year the federal government has authorized 700 million dollars for these systems. Statistics prepared by the Bureau of Public Roads show that if the existing program were continued, at the end of ten years only 31 per cent of our Primary System and only 27 per cent of our Secondary System would be constructed to adequate standards. This information was not encouraging. It was hoped that the "Grand Plan" would provide an adequate answer to this problem, but the answer of the Administration Bill was to reduce the present level of expenditures on these systems from 700 million dollars to 600 million dollars and to freeze it at that level for the next thirty-five or forty years.

You may be interested in knowing how the Primary and Secondary Systems would fare under the Administration Bill. They would come out considerably short of the goal set in the "Grand Plan." If the Administration Bill were enacted, at the end of ten years the Primary System would be 25 per cent complete, as compared to 31 per cent if we merely continued the existing law, which is admitted'y inadequate. The Secondary System would hold its own. After ten years under the Administration Bill, it would be 27 per cent complete—exactly the same if we merely continued our existing program. To me, this would be an unbalanced program.

As important as they are, the interstate highways carry only one-seventh of the nation's traffic. I know of no better way of illustrating this point than that used by the Administration itself in support of its bill when its representatives appeared before the Senate Public Works Committee. A skilled draftsman had prepared on chart paper a rather large-scale replica of a tree, which was displayed to the Committee. The trunk and taproot of the tree were designated as the Interstate System. The principal branches and larger roots represented the Primary System, while the tiny branches extending from the main limbs and the small silken extensions of the roots represented the Secondary System. In this display the trunk and taproot signified the

basic importance of the Interstate System, supporting the whole tree. But I ask you in all seriousness, what would happen to the trunk of that tree if the leaves attached to the tiny branches failed to absorb the energy of the sun and if those tiny finger-like roots were not there to gather moisture and nutrition from the soil?

A wonderful system of super interstate highways would be fine, and I want the nation to have it—but standing alone, it is not enough. That is why the Senate Bill provides for increased authorizations for *all* segments of the federal-aid system. It is true that the Senate Bill places major emphasis, both in terms of federal share and in terms of total dollars, on the Interstate System, but at the same time, it increases funds for the Primary and Secondary segments of our federal-aid system from 700 million to 900 million dollars a year.

The House Committee also recognized the necessity for accelerating construction of our Primary, Secondary, and Urban highways, but the House Bill did not go so far as to make actual authorizations beyond 1957. The Bill contained a declaration of policy stating that the funds for these segments should be increased by 25 million dollars each year. It may be that future Congresses would have recognized and implemented this statement of policy had the House Bill been enacted into law. I do feel, however, that failure to make an actual authorization for all federal-aid roads tends to make a highway bill have too exclusive an interstate flavor. I think it extremely important that we not be so preoccupied with the Interstate System that we lose sight of the importance of other segments of our highway system.

It is perhaps ironic, but sponsors of the Administration Bill criticized the Senate Bill on the grounds that the states could not raise sufficient funds to match increased authorizations for Primary and Secondary roads. At the same time, the Administration was promoting its "Grand Plan" under which the states were supposed to improve these roads all alone, themselves paying 100 per cent of the cost. I cannot conceive how a state could be expected to raise 100 per cent of the cost of these roads if they cannot raise sufficient money to match moderately increased federal money on a fifty-fifty basis. In all candor, I know the states are pressed for money, but I believe that the availability of additional matching funds would spur the efforts of states to do their part of the job.

Throughout the history of the federal government's highway program federal funds have been apportioned to states on the basis of a formula prescribed by the Congress. The Administration Bill proposed to abandon the apportionment concept for the 25 billion dollars to be spent on the Interstate System. The huge sum was to be spent at the discretion of the Secretary of Commerce. Now, I just do not believe it would be consistent with the public interest to place this much authority in the hands of any one person, be he of a Democratic or of a Republican Administration. As Governor Hugh White of Mississippi has said, "Those people in Washington might wake up with indigestion some morning and decide not to give my state any money." I am confident that Congress, in recognition of its Constitutional responsibility for the expenditure of the taxpayer's money, will never agree to make a permanent appropriation of such huge sums, with the money to go into a "kitty" to be doled out on the basis of what the Secretary of Commerce considers to be the needs of the various states.

The House Committee Bill had a provision which was described as an apportionment, but its inequitableness was surpassed only by its lack of justification.

There is room for argument as to what formula might be most equitable—but there must be a formula.

Both the Senate Bill and the House Bill retain the basic framework of existing law under which our federal road program is administered by the Bureau of Public Roads, in cooperation with state highway departments. Even more important these bills reserve to the Congress full authority for review and control of the program. The Administration Bill discarded this Congressional control. It provided for a permanent appropriation to a Corporation whose officers would serve at the pleasure of the President. This Corporation was to be given 25 billion dollars of the taxpayer's money to play around with. Under the bill, the Corporation could spend this sum in five years, in ten years, or in thirty years. Assuming the money was spent in ten years as proposed by the sponsors of the bill, this Corporation would continue for some further period of indefinite duration—at least twenty additional years—to have first call upon all highway funds in excess of 600 million dollars a year, to retire its bonds. There would be no source of funds for improvement of our highways during this twenty-year period.

The till would be dry. Now, I realize that the Congress could always repeal or modify the law, but in practical effect, it could not do so once the bonds were issued because there would be no moral obligation on the part of the government to provide money to pay off the bonds.

In my opinion, it would be most unwise for Congress to abandon its control over the highway program. The fate of the Administration Bill in both Houses during the first session indicates that the membership of both the House and the Senate shared this opinion.

Now, what about this question of paying for roads? Somehow, the money must be provided—and it can't be done with mirrors. Nobody would be more pleased than I if some method could be devised whereby the federal government could build roads without paying for them with money from the Treasury of the United States. No such way has, as yet, been found. If the federal government spends money outside the Budget, it is spent nonetheless. If bonds are issued outside the public debt, it is deficit financing just the same. As mentioned earlier, under each of the three bills, money to pay for the roads would come from general funds of the Treasury. Neither the Senate Bill nor the Administration Bill levied any taxes to increase the money in the bank. The House Bill did.

Under the legislative procedures employed by Congress, we have three broad categories of legislation. We have authorization bills which set up programs. There are appropriation bills to pay for them; and we have tax bills which bring revenue into the Treasury. It has never been a general practice of Congress to include more than one of these functions in a single act. Nor has it been the practice of Congress to make any particular program dependent upon revenues from any particular tax. I know that many of our states earmark certain of their revenues. Perhaps upon a state level, in some instances, earmarking may be the only practical solution. But I believe—at least on the national level—that earmarking of taxes is dangerous. Further, I fail to see why, of all government programs, the highway program should be penalized by singling it out and providing that there can be no roads unless, or except to the extent, they can be paid for from a particular source of revenue. We don't operate our farm program that way or any other major program of the government.

So far as I am concerned, I believe our government should operate on a pay-as-you-go basis to the maximum extent possible, and certainly during peacetime. I feel that highway construction should be financed by direct appropriations by the Congress. If highway expenditures, added to all other government expenditures, require more money than current taxes provide, then I am willing to support measures to bring in more revenues so as to avoid deficit financing. But I wonder if that question should not be handled in a separate tax bill, which, under our Constitution, must originate in the House of Representatives.

It is my further opinion that in selecting the source or sources for additional funds, Congress should examine the entire tax base. A good place to start would be the repeal of some of the loopholes and inequitable tax short-cuts in the present tax law. After that, it may well be that a full study would indicate that additional revenues should be raised by increasing some highway user taxes. If that should be indicated, I would support it. The thing to remember is that we have to pay for all Government programs—not just for highways. We have to raise money to do it and we have to keep our tax program in balance.

Congress considered all of these points for several months during the first session. Despite virtually unanimous agreement on the need for a program, no highway bill was enacted. But January will be here almost before we know it and there will be another opportunity for Congress to act. The question is: Where do we go from here?

We must look ahead to the next session. The Senate has already passed a bill. If the House can pass a reasonable bill next year, we will have a highway program.

I hope it has been evident to you that I think the Senate Bill is a good bill. I don't say it is perfect—nor is every provision in the bill exactly as I would like to have it. It was written by thirteen members of the Senate Public Works Committee, sitting around a table after having listened for twenty-one days to testimony on the subject. It was shaped into its final form on the Floor of the Senate, after several days of give-and-take debate.

In my opinion, the Senate Bill provides for acceleration of our highway program as fast as the industry can expand without inflating the cost of highways. The Senate Bill places major emphasis and most of the money on the Interstate System,

(*Continued on page 22*)

Penetration Macadam Base Course Construction

By JOSEPH E. GRAY

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ECONOMICS as well as engineering sufficiency invariably enter into the selection of pavement types and of the various pavement courses. In some areas of the country penetration macadam had to be built at a cost no greater than waterbound or sandbound macadam to be given consideration as a base course. This economic challenge has been met through slight modification in design, improved equipment, and more efficient methods of construction. Probably the largest project to use this modified penetration macadam was the New Jersey Turnpike which was built in 1951. Some of the New England states, notably Massachusetts, have been using this particular type of penetration macadam successfully, and now it is a standardized component of flexible pavement design. Four inches of penetration macadam forms the base course for the bituminous concrete binder and surfacing courses on the extension of the Main Turnpike. Since this project is an excellent example of this modern method of construction it will be described and discussed in the following.

Preparation for Sub-base

The sub-base material consisted of bank run sand and gravel which was compacted to a high density and tested by the use of the 50 ton pneumatic tire super compactor so that there were practically no soft spots when the rough grading had been completed. Fine grading was performed immediately ahead of placing the macadam stone. The sub-base material for fine grading was essentially bank sand which was brought to slightly above grade by a blade grader. It then was compacted by a self-propelled multiple tire roller and two 17-21 ton tandem rollers (Figure 1). Water was sprinkled over the surface during this rolling. A crown of 2 in. in the the 25 ft width was built into this sub-base which was checked for grade at 25 ft intervals. This sub-base or foundation course was built with the care that is due any first class paving operation. It presented an excellent surface for the stone spreaders to operate on, and undoubtedly was the determining factor in obtaining the first rate smoothness of surface in the subsequent courses.

Penetration Macadam Base Course

The design for the Turnpike required a base course of 4 in. of penetration macadam to be topped by bituminous concrete binder and surfacing courses This base course was built essentially as follows.

The gradation specifications for the stone and the gradation actually used were:

Sieve Size	Coarse Aggregate Spec.	Coarse Aggregate Used	Keystone Spec.	Keystone Used	Chips Spec.	Chips Used
2 1/2 in.	100	100				
2 in.	90-100	—				
1 1/2 in.	35-70	42				
1 in.	0-15	3	100	100		
3/4 in.			90-100	99		
1/2 in.			—	—	100	100
3/8 in.			20-55	20	85-100	87
No. 4			0-10	3	10-30	26
No. 8			0-5	2	0-10	4
No. 16					0-5	2

The coarse aggregate was spread to a loose depth of 5 in. for a full width of 25 ft by two stone spreaders working side by side (Figures 2 and 3).

An inspector constantly checked the thickness of the layer immediately behind the stone spreaders. Next, a crew of six men with stone forks evened the entire surface. They removed the excess stone at the longitudinal joint and all high spots, and filled all low spots (Figure 4). The work of these men was important in obtaining a smooth, uniform surface of loose stone. In fact, the surface of the loose stone was remarkably even before any rolling (Figure 5). The stone then was rolled with a 15 ton 3 wheel tandem roller which began at the outside and rolled longitudinally only, overlapped well on each trip, and worked toward the center, thereby maintaining the crown of 2 in. The thickness after rolling was 4 in.

After the stone was rolled and well interlocked, 95-100 penetration asphalt was applied at the rate of 1.5 gal per sq yd (Figures 6 and 7). Immediately following the application of asphalt, while it was

still hot and sticky, the surface was again rolled with the 15 ton 3 wheel tandem roller. Water was wiped over the surface of the rollers by means of attached mats to prevent adherence of the asphalt. Rolling while the asphalt was hot appeared to give additional compaction to a surface even though it seemed stable when rolled dry.

Following this rolling, keystone was applied at the rate of approximately 28 lb per sq yd under a specification which required 20-30 lb per sq yd (Figure 8). The keystone was rolled, broom dragged, and re-rolled until it was uniformly distributed in the surface voids. This rate of application of keystone was thought to be just right for the size of coarse aggregate because it well filled the large voids in the surface without forming a mat.

A seal coat was applied next, which consisted of spraying the keyed surface with 0.3 gal per sq yd of 95-100 penetration asphalt and covering it with about 21 lb per sq yd of 1/2 in. chips (Figure 9). These chips were rolled, broom dragged, and re-rolled until they were worked well into the surface voids. This completed the penetration macadam base course.

As soon as the macadam course was completed it was opened to construction traffic which consisted, for the most part, of heavily loaded stone trucks. In the short time of about a couple of weeks, this traffic had worked the chips and keystone down into the surface voids to expose the large coarse aggregate, which made a tight mosaic appearing surface that seemed ideal for the subsequent bituminous concrete courses, as may be seen in Figure 10.

FIGURE 1
Subgrade Prepared to True Cross-section and Compacted With 17-21 Ton Rollers

FIGURE 2
Two Stone Spreaders Working Side by Side Lay Stone to About 5 in. Loose Depth

Discussion

It is generally conceded that density is not necessary in penetration macadam base course, and that the quantity of asphalt used does not fill the voids and may not penetrate to the bottom of the course. However, it is believed to be necessary to roll the course thoroughly so that it will be compacted, well interlocked, and stable. Rolling of the stone while the asphalt is hot seems to further this objective. Likewise, with the hard and tough stone that is available in New England, the use of heavy rollers is effective in that they compact without crushing the aggregate. If the course is thoroughly compacted and the surface is stable, the macadam will be a good base. However, the proper keying of the surface adds greatly to its stability. The keystone must be of the correct gradation in relation to the surface voids in the coarse stone. For the job described, the keystone was of the right size

FIGURE 3
Close-up of Stone Spreader Showing Reciprocating Screed at Rear of Stone Box

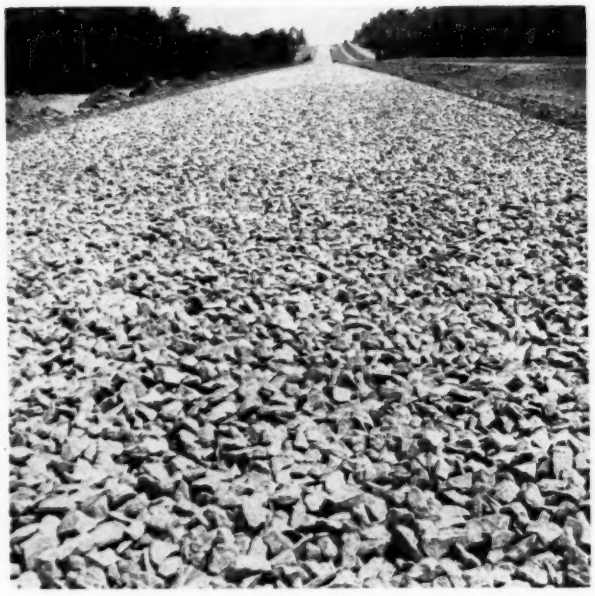

FIGURE 5
Spread Loose Stone Prior to Rolling

FIGURE 4
Evening the Surface at the Junction of the Two Spreaders

FIGURE 6
Applying 1.5 gal per sq yd of Hot Asphalt

FIGURE 7
Second Rolling of Stone Course Immediately After Applying Asphalt. The Asphalt is Hot and Fluid

and used in the correct amount in the opinion of engineers of many years of experience in penetration macadam construction. When the keystone had been worked into the surface voids, the course was stable.

The rolling of the coarse stone immediately after spraying hot asphalt, while believed to be advantageous, has some limitation. This limitation is primarily dependent upon the grade on which the stone has to be rolled. On relatively flat grades no trouble ensues, but if the grade is steep enough to cause a wave in front of the roller, then rolling must be stopped until the asphalt has cooled and set enough to permit rolling without forward movement of the stone. Some persons have expressed the fear that water from the rollers would have a detrimental effect on the asphalt; however, the actual amount of water which comes in contact with the asphalt is very small and no trouble from this source has been observed or reported.

Another point in New England construction practice that should be mentioned is the general use of heavy rollers, say 12 to 18 tons. Naturally, these heavy rollers do a good job of consolidating the stone, but their satisfactory use is dependent upon stone that does not crush under the roller. To accomplish this the stone must be hard and tough, which is a characteristic of trap rock, or of a size large enough to withstand rolling; otherwise lighter weight rollers have to be used. In areas where softer stone is used, particularly limestone, penetration macadam base courses are often built with stone of 3 in. maximum size and the rollers are about 10 tons in weight. The 3 in. coarse stone would require the use of a larger size keystone; about 1 in. maximum size is believed to be about right.

The question may naturally arise as to how the correct rate of application of asphalt is determined, since the voids are not filled to any pre-determined amount. To the best of my knowledge, the only answer is through experience and judgment. It, therefore, may be of interest to tabulate the rate of application of asphalt on a few outstanding projects in which similar methods of construction were used:

Project	Size of of Stone, in.	Thickness of Course, in.	Asphalt, gal per sq yd
New Jersey Turnpike, 1st course	1-2	4 1/2	1.6-1.8
New Jersey Turnpike, 2nd course	1-1 1/2	3	1.6-1.8
Boston Expressway	1-2	4 1/2	1.75
Maine Turnpike Extension	1-2	4	1.5

A change has been taking place in penetration macadam base construction which effects further economies. This is the elimination of the seal. While

FIGURE 8
After Rolling, 3/4 in. Keystone or Chokestone is Applied at Rate of About 28 lb per sq yd

the job described had the seal coat which seemed to serve a useful purpose because, when left open to construction traffic for a relatively short time of a few weeks, the surface became dense and tight, with the voids well filled with the small stone. Nonetheless, the trend is to omit the seal coat. Even some sections of this Maine project were being built without the seal.

In Massachusetts the standard construction practice in penetration macadam base is to omit the seal whenever it is to be immediately surfaced with bituminous concrete. The reasoning behind this practice is that a seal coat is for the purpose of providing a watertight surface and, since a hot dense bituminous binder course serves this purpose, the seal treatment is a superfluous operation. There is a history of at least five years of satisfactory performance of penetration macadam base course built without a seal coat in support of this practice.

There exists in some sections of the country a reluctance to use macadam base courses because the claim is made that they do not provide a sufficiently smooth surface upon which may be placed a surfacing course that will have good riding qualities. Several sections of the completed penetration macadam were driven over at various speeds with Charles Parker, Consulting Engineer for Paving, and

FIGURE 9
1/2 in. Chips Applied at About 21 lb per sq yd to Complete Seal Coat

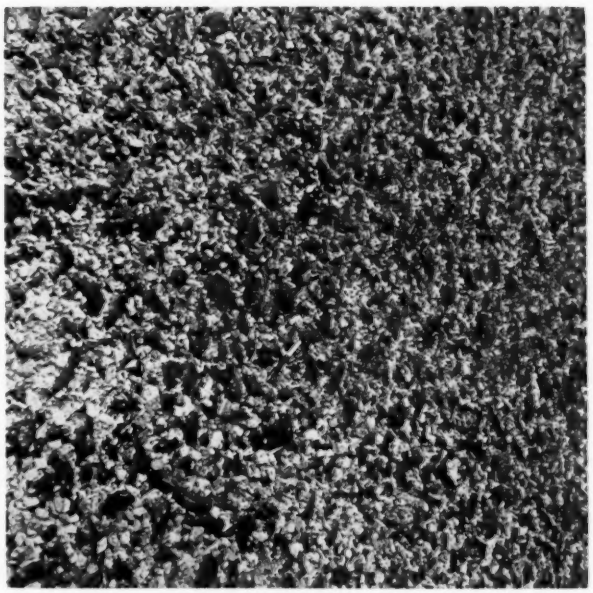

FIGURE 10
Final Surface After About Two Weeks of Construction Traffic

it seemed to us that the surface was smooth and quite free of undulations, which led us to believe that the riding qualities of the completed pavement should be very good. Next, we drove over some sections of the completed pavement and the riding qualities of these sections were excellent. The riding qualities of flexible pavements on arterial highways in the northeastern section of the country, in general, are very good. The logical inference is that these base courses, when built by first rate contractors with proper design, inspection, and control, provide a good surface upon which may be placed subsequent courses of bituminous concrete which will possess excellent riding qualities.

Acknowledgment

The extension of the Maine Turnpike was divided into two projects. The Lane Construction Company had the contract for the southern half, terminating at Portland, and the Savin Construction Corporation had the contract for the northern half which ended at Augusta. Charles Parker was Consulting Engineer for Paving, and Louis B. Litchfield was Resident Engineer for the firm of Howard, Needles, Tammen, and Bergendoff on the northern project, which is the one described and photographed.

The 1954 National Crushed Stone Association Safety Competition

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U. S. Bureau of Mines
Washington, D. C.

THE injury experience at operations enrolled in the National Crushed Stone Safety Competition of 1954 was, by far, one of the best since the contest was inaugurated 29 years ago, according to the Bureau of Mines, United States Department of the Interior.

The frequency rate, 16.923 injuries per million man-hours of worktime in the 1954 competition, was the next to the lowest rate ever made in the history of the contest—in 1939 the rate was 13.660—and the severity rate of 3.227 although not so good as the previous year, has been better in only 5 other previous years. Although the injury record of the competing operations has not been improved from year to year, a definite progressive improvement has been attained over the 29-year span of the contest.

The Winning Operation

Top safety honors were won by the Bell underground limestone mine, Bellefonte Division, of the Warner Company at Bellefonte, Centre County, Pennsylvania, for having operated a total of 246,689 man-hours during the year without a lost-time injury. For this outstanding safety accomplishment, a bronze plaque provided by The Explosives Engineer Magazine was won by this plant, and in recognition of the part each employee and official played in making this safety record possible, each is awarded a certificate by the National Crushed Stone Association.

The Greystone quarry of the Greystone Granite Quarries, Incorporated at Henderson, Vance County, North Carolina, the winner of top honors in 1953, ranked second in the 1954 contest for having an injury-free year during an aggregate of 223,902 man-hours. Third place in the contest was North Branford No. 7 quarry of the New Haven Trap Rock Company, at North Bradford, New Haven County, Connecticut, for operating 119,379 injury-free man-hours. The fourth-ranking plant was the Kimballton underground limestone mine of the Standard Lime and Stone Company at Kimballton, Giles County, Virginia. This operation had no lost-time injuries during 104,065 man-hours of worktime.

Injury-Free Operations

Including the trophy winner, 6 underground mines and 15 quarries had no disabling injuries during the contest year. These 21 mines and quarries were worked a total of 1,540,303 man-hours or 23 per cent of the total time worked by all 67 operations participating in the 1954 contest.

These injury-free plants, including the trophy winner, were as follows:

Bell Mine, Warner Company—Bellefonte Division, Bellefonte, Centre County, Pennsylvania; 246,689 man-hours.

Greystone Quarry, Greystone Granite Quarries, Incorporated, Henderson, Vance County, North Carolina; 223,902 man-hours.

North Branford No. 7 Quarry, New Haven Trap Rock Company, North Branford, New Haven County, Connecticut; 119,379 man-hours.

Kimballton Mine, Standard Lime and Cement Company, Kimballton, Giles County, Virginia; 104,065 man-hours.

Red Hill Quarry, Superior Stone Company, Charlottesville, Albemarle County, Virginia; 101,135 man-hours.

Rock Hill Quarry, General Crushed Stone Company, Quakertown, Bucks County, Pennsylvania; 95,538 man-hours.

Woodleaf Quarry, Superior Stone Company, Woodleaf, Rowan County, North Carolina; 91,161 man-hours.

TABLE I

RELATIVE STANDING OF QUARRIES IN THE 1954 NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION, BASED UPON THE INJURY-SEVERITY RATES OF THE QUARRIES [1]

Rank	Man-hours worked	Number of injuries [2]					Average days of disability per temp. injury	Number of days of disability [2]					Frequency rate [3]	Severity rate [3]
		F.	P.T.	P.P.	Temp.	Total		F.	P.T.	P.P.	Temp.	Total		
2	223,902	—	—	—	—	—	—	—	—	—	—	—	0.000	0.000
3	119,379	—	—	—	—	—	—	—	—	—	—	—	.000	.000
5	101,135	—	—	—	—	—	—	—	—	—	—	—	.000	.000
6	95,538	—	—	—	—	—	—	—	—	—	—	—	.000	.000
7	91,161	—	—	—	—	—	—	—	—	—	—	—	.000	.000
8	84,730	—	—	—	—	—	—	—	—	—	—	—	.000	.000
9	69,750	—	—	—	—	—	—	—	—	—	—	—	.000	.000
10	58,707	—	—	—	—	—	—	—	—	—	—	—	.000	.000
11	56,848	—	—	—	—	—	—	—	—	—	—	—	.000	.000
13	46,784	—	—	—	—	—	—	—	—	—	—	—	.000	.000
14	46,213	—	—	—	—	—	—	—	—	—	—	—	.000	.000
16	27,104	—	—	—	—	—	—	—	—	—	—	—	.000	.000
17	20,134	—	—	—	—	—	—	—	—	—	—	—	.000	.000
18	19,395	—	—	—	—	—	—	—	—	—	—	—	.000	.000
21	10,673	—	—	—	—	—	—	—	—	—	—	—	.000	.000
22	101,097	—	—	—	1	1	1	—	—	—	1	1	9.891	.010
23	95,011	—	—	—	1	1	1	—	—	—	1	1	10.525	.011
24	141,178	—	—	—	1	1	3	—	—	—	3	3	7.083	.021
25	168,814	—	—	—	1	1	4	—	—	—	4	4	5.924	.024
26	148,797	—	—	—	2	2	5	—	—	—	9	9	13.441	.060
27	79,115	—	—	—	1	1	5	—	—	—	5	5	12.640	.063
30	59,075	—	—	—	2	2	3	—	—	—	5	5	33.855	.085
32	32,197	—	—	—	1	1	4	—	—	—	4	4	31.059	.124
33	135,765	—	—	—	1	1	32	—	—	—	32	32	7.366	.236
34	149,442	—	—	—	1	1	39	—	—	—	39	39	6.692	.261
35	207,948	—	—	—	3	3	19	—	—	—	56	56	14.427	.269
36	242,047	—	—	—	2	2	39	—	—	—	78	78	8.263	.322
37	257,454	—	—	—	2	2	43	—	—	—	85	85	7.768	.330
38	53,565	—	—	—	2	2	9	—	—	—	18	18	37.378	.336
39	136,000	—	—	—	2	2	25	—	—	—	50	50	14.706	.368
40	59,775	—	—	—	1	1	22	—	—	—	22	22	16.729	.368
41	30,976	—	—	—	4	4	4	—	—	—	17	17	129.132	.549
42	183,984	—	—	—	4	4	26	—	—	—	102	102	21.741	.554
43	164,112	—	—	—	5	5	19	—	—	—	97	97	30.467	.591
44	56,993	—	—	—	2	2	17	—	—	—	34	34	35.092	.597
45	117,656	—	—	—	1	1	75	—	—	—	75	75	8.499	.637
46	27,012	—	—	—	1	1	20	—	—	—	20	20	37.021	.740
47	109,117	—	—	—	7	7	16	—	—	—	109	109	64.151	.999
48	113,472	—	—	—	8	8	15	—	—	—	118	118	70.502	1.040
49	82,642	—	—	—	2	2	46	—	—	—	92	92	24.201	1.113
50	34,352	—	—	—	4	4	11	—	—	—	44	44	116.442	1.281
51	58,170	—	—	1	—	1	—	—	—	75	—	75	17.191	1.289
52	89,762	—	—	—	3	3	42	—	—	—	126	126	33.422	1.404
54	154,375	—	—	—	8	8	30	—	—	—	241	241	51.822	1.561
55	72,697	—	—	—	4	4	35	—	—	—	140	140	55.023	1.926
56	60,544	—	—	—	4	4	30	—	—	—	118	118	66.068	1.949
57	162,488	—	—	1	1	2	69	—	—	250	69	319	12.309	1.963
58	103,436	—	—	1	1	2	1	—	—	250	1	251	19.336	2.427
59	676,419	—	—	1	6	7	22	—	—	1,800	131	1,931	10.349	2.855
61	31,781	—	—	—	1	1	115	—	—	—	115	115	31.465	3.619
62	23,621	—	—	—	1	1	90	—	—	—	90	90	42.335	3.810
63	54,733	—	—	1	—	1	—	—	—	240	—	240	18.271	4.385
64	157,464	—	—	1	1	2	93	—	—	1,665	93	1,758	12.701	11.164
65	132,320	—	—	2	1	3	13	—	—	2,250	13	2,263	22.672	17.102
67	43,369	1	—	1	2	4	8	6,000	—	375	15	6,390	92.232	147.340
Totals and rates:														
1954	5,880,228	1	—	9	95	105	24	6,000	—	6,905	2,272	15,177	17.856	2.581
1953	6,555,333	—	—	9	114	123	25	—	—	14,892	2,882	17,774	18.763	2.711

[1] As reports from mining companies are considered confidential by the Bureau of Mines, the identities of the operations to which this table relates are not revealed

[2] F., fatal; P. T., permanent total disability; P. P., permanent partial disability; Temp., temporary disability

[3] Frequency rate indicates the number of fatal, permanent, and other disabling injuries per million man-hours of exposure; severity rate indicates the number of days of disability lost from injuries per thousand man-hours of exposure

TABLE II

RELATIVE STANDING OF UNDERGROUND MINES IN THE 1954 NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION, BASED UPON THE INJURY-SEVERITY RATES OF THE MINES[1]

Rank	Man-hours worked	Number of injuries [2]					Average days of disability per temp. injury	Number of days of disability [2]					Frequency rate [3]	Severity rate [3]
		F.	P.T.	P.P.	Temp.	Total		F.	P.T.	P.P.	Temp.	Total		
1	246,689	—	—	—	—	—	—	—	—	—	—	—	0.000	0.000
4	104,065	—	—	—	—	—	—	—	—	—	—	—	.000	.000
12	54,476	—	—	—	—	—	—	—	—	—	—	—	.000	.000
15	30,382	—	—	—	—	—	—	—	—	—	—	—	.000	.000
19	18,336	—	—	—	—	—	—	—	—	—	—	—	.000	.000
20	14,902	—	—	—	—	—	—	—	—	—	—	—	.000	.000
28	31,601	—	—	—	1	1	2	—	—	—	2	2	31.645	.063
29	61,441	—	—	—	2	2	3	—	—	—	5	5	32.552	.081
31	19,568	—	—	—	1	1	2	—	—	—	2	2	51.104	.102
53	216,998	—	—	—	2	2	156	—	—	—	311	311	9.217	1.433
60	44,000	—	—	—	1	1	132	—	—	—	132	132	22.727	3.000
66	72,904	1	—	—	2	3	151	6,000	—	—	302	6,302	41.150	86.442
Totals and rates:														
1954	915,362	1	—	—	9	10	84	6,000	—	—	754	6,754	10.925	7.379
1953	1,260,523	—	—	—	12	12	41	—	—	—	487	487	9.520	0.386

[1] As reports from mining companies are considered confidential by the Bureau of Mines, the identities of the operations to which this table relates are not revealed
[2] F., fatal; P. T., permanent total disability; P. P., permanent partial disability; Temp., temporary disability
[3] Frequency rate indicates the number of fatal, permanent, and other disabling injuries per million man-hours of exposure; severity rate indicates the number of days of disability lost from injuries per thousand man-hours of exposure

TABLE III

YEARLY SUMMARY—QUARRIES IN THE NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION, 1926–54 [1]

Year	Plants	Man-hours worked	Number of injuries [2]					Number of days of disability [2]					Frequency rate [3]	Severity rate [3]
			F.	P. T.	P. P.	Temp.	Total	F.	P. T.	P. P.	Temp.	Total		
1926	40	5,298,983	3	—	6	207	216	18,000	—	9,000	4,239	31,239	40.763	5.895
1927	48	7,876,791	9	—	2	458	469	54,000	—	2,100	7,186	63,286	59.542	8.034
1928	53	7,509,098	8	—	4	322	334	48,000	—	8,700	5,493	62,193	44.479	8.282
1929	53	7,970,325	4	—	5	286	295	24,000	—	5,760	5,533	35,293	37.012	4.428
1930	68	8,013,415	6	—	9	227	242	36,000	—	7,250	3,671	46,921	30.199	5.855
1931	58	5,085,857	4	—	13	198	215	24,000	—	18,660	3,540	46,200	42.274	9.084
1932	40	2,661,850	1	—	4	75	80	6,000	—	6,750	2,481	15,231	30.054	5.722
1933	40	2,704,871	1	—	1	67	69	6,000	—	48	2,893	8,941	25.510	3.306
1934	46	3,288,257	1	—	2	106	109	6,000	—	2,850	1,873	10,723	33.148	3.261
1935	46	4,166,306	2	1	8	77	88	12,000	6,000	9,900	3,015	30,915	21.122	7.420
1936	50	6,399,023	5	—	14	182	201	30,000	—	8,168	4,590	42,758	31.411	6.682
1937	47	6,199,001	7	—	9	136	152	42,000	—	5,875	4,461	52,336	24.520	8.443
1938	47	4,658,119	2	—	6	76	84	12,000	—	6,600	3,184	21,784	18.033	4.677
1939	44	4,219,086	2	—	2	51	55	12,000	—	4,800	1,678	18,478	13.036	4.380
1940	46	4,358,409	1	—	5	78	84	6,000	—	2,550	3,013	11,563	19.273	2.653
1941	47	5,777,587	3	—	5	98	106	18,000	—	9,300	2,266	29,566	18.347	5.117
1942	48	7,178,935	3	2	1	183	189	18,000	12,000	1,500	4,239	35,739	26.327	4.978
1943	34	4,750,314	4	—	5	134	143	24,000	—	7,146	3,862	35,008	30.103	7.370
1944	32	3,996,433	3	—	4	118	125	18,000	—	3,000	3,323	24,323	31.278	6.086
1945	46	6,087,037	—	—	1	135	136	—	—	750	3,505	4,255	22.343	0.699
1946	46	7,292,175	1	—	6	197	204	6,000	—	5,141	4,130	15,271	27.975	2.094
1947	42	6,971,790	5	—	5	197	207	30,000	—	6,900	4,990	41,890	29.691	6.008
1948	47	6,953,569	4	—	11	181	196	24,000	—	8,018	4,642	36,660	28.187	5.272
1949	57	7,166,644	3	—	11	153	167	18,000	—	9,465	3,345	30,810	23.302	4.299
1950	45	6,510,173	2	—	7	153	162	12,000	—	3,854	3,825	19,679	24.884	3.023
1951	36	5,441,304	1	—	4	100	105	6,000	—	6,325	2,381	14,706	19.297	2.703
1952	36	5,279,849	3	—	3	111	117	18,000	—	1,674	2,296	21,970	22.160	4.161
1953	47	6,555,333	—	—	9	114	123	—	—	14,892	2,882	17,774	18.763	2.711
1954	55	5,880,228	1	—	9	95	105	6,000	—	6,905	2,272	15,177	17.856	2.581
Total	—	166,250,762	89	3	171	4,515	4,778	534,000	18,000	183,881	104,808	840,689	28.740	5.057

[1] As reports from mining companies are considered confidential by the Bureau of Mines, the identities of the operations to which this table relates are not revealed
[2] F., fatal; P. T., permanent total disability; P. P., permanent partial disability; Temp., temporary disability
[3] Frequency rate indicates the number of fatal, permanent, and other disabling injuries per million man-hours of exposure; severity rate indicates the number of days of disability lost from injuries per thousand man-hours of exposure

TABLE IV

YEARLY SUMMARY—UNDERGROUND MINES IN THE NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION, 1926–54 [1]

Year	Plants	Man-hours worked	Number of injuries [2]					Number of days of disability [2]					Frequency rate [3]	Severity rate [3]
			F.	P. T.	P. P.	Temp.	Total	F.	P. T.	P. P.	Temp.	Total		
1926	3	517,926	—	—	—	34	34	—	—	—	533	533	65.646	1.029
1927	2	318,449	1	—	1	14	16	6,000	—	300	68	6,368	50.244	19.997
1928	5	542,193	1	—	1	68	70	6,000	—	300	888	7,188	129.105	13.257
1929	4	665,520	1	—	1	30	32	6,000	—	300	617	6,917	48.083	10.393
1930	6	595,367	1	—	1	15	17	6,000	—	225	468	6,693	28.554	11.242
1931	3	345,105	—	—	—	4	4	—	—	—	147	147	11.591	.426
1932	2	158,450	—	—	—	6	6	—	—	—	165	165	37.867	1.041
1933	3	229,381	—	—	—	11	11	—	—	—	349	349	47.955	1.521
1934	4	248,146	—	—	—	13	13	—	—	—	287	287	52.389	1.157
1935	2	175,994	—	—	—	3	3	—	—	—	249	249	17.046	1.415
1936	4	334,747	1	—	—	7	8	6,000	—	—	117	6,117	23.899	18.274
1937	3	364,680	—	—	—	3	3	—	—	—	91	91	8.226	.250
1938	3	334,442	—	—	—	2	2	—	—	—	133	133	5.980	.398
1939	4	393,039	—	—	1	7	8	—	—	600	457	1,057	20.354	2.689
1940	4	375,987	—	—	1	8	9	—	—	4,500	888	5,388	23.937	14.330
1941	4	591,568	—	—	1	15	16	—	—	750	169	919	27.047	1.553
1942	4	785,894	—	—	1	33	34	—	—	1,800	1,213	3,013	43.263	3.834
1943	5	1,019,771	—	—	3	45	48	—	—	4,950	1,123	6,073	47.069	5.955
1944	4	727,496	1	—	1	27	29	6,000	—	2,400	796	9,196	39.863	12.641
1945	7	1,238,845	—	—	2	22	24	—	—	3,000	755	3,755	19.373	3.031
1946	8	1,338,563	2	—	2	31	35	12,000	—	675	1,045	13,720	26.147	10.250
1947	8	1,291,162	5	—	1	29	35	30,000	—	75	1,588	31,663	27.107	24.523
1948	4	940,031	—	—	—	16	16	—	—	—	935	935	17.021	.995
1949	5	981,692	—	—	1	17	18	—	—	900	467	1,367	18.336	1.392
1950	6	1,102,273	1	—	1	25	27	6,000	—	3,000	810	9,810	24.495	8.900
1951	6	1,179,458	—	—	1	21	22	—	—	1,125	818	1,943	18.653	1.647
1952	6	1,137,449	—	—	—	19	19	—	—	—	583	583	16.704	.513
1953	6	1,260,523	—	—	—	12	12	—	—	—	487	487	9.520	.386
1954	12	915,362	1	—	—	9	10	6,000	—	—	754	6,754	10 925	7.379
Total	—	20,109,513	15	—	20	546	581	90,000	—	24,900	17,000	131,900	28.892	6.559

[1] As reports from mining companies are considered confidential by the Bureau of Mines, the identities of the operations to which this table relates are not revealed
[2] F., fatal; P. T., permanent total disability; P. P., permanent partial disability; Temp., temporary disability
[3] Frequency rate indicates the number of fatal, permanent, and other disabling injuries per million man-hours of exposure; severity rate indicates the number of days of disability lost from injuries per thousand man-hours of exposure

Jordanville Quarry, General Crushed Stone Company, Jordanville, Herkimer County, New York; 84,730 man-hours.

Watertown Quarry, General Crushed Stone Company, Watertown, Jefferson County, New York; 69,750 man-hours.

Union Furnace Quarry, Warner Company—Bellefonte Division, Tyrone, Blair County, Pennsylvania; 58,707 man-hours.

Cedar Hollow Quarry, Warner Company, Devault, Chester County, Pennsylvania; 56,848 man-hours.

Yellow Rock Mine, Kentucky Stone Company, Yellow Rock, Lee County, Kentucky; 54,476 man-hours.

Cape Girardeau Quarry, Federal Materials Company, Cape Girardeau, Cape Girardeau County, Missouri; 46,784 man-hours.

Prospect Stone Plant No. 6, Eastern Rock Products Incorporated, Prospect, Oneida County, New York; 46,213 man-hours.

Tyrone Mine, Kentucky Stone Company, Lawrenceburg, Anderson County, Kentucky; 30,382 man-hours.

Avoca Quarry, Jefferson County Stone Company, Avoca, Jefferson County, Kentucky; 27,104 man-hours.

Plant No. 4 Quarry, Southwest Stone Company, Knippa, Uvalde County, Texas; 20,134 man-hours.

Randville Quarry, Superior Rock Products Company, Sagola, Dickinson County, Michigan; 19,395 man-hours.

No. 7 Quarry, Columbia Quarry Company, Elsberry, Lincoln County, Missouri; 18,336 man-hours.

High Bridge Mine, Kentucky Stone Company, High Bridge, Jessamine County, Kentucky; 14,902 man-hours.

Elkton Quarry, Kentucky Stone Company, Elkton, Todd County, Kentucky; 10,673 man-hours.

TABLE V

YEARLY SUMMARY—QUARRIES AND UNDERGROUND MINES IN THE NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION, 1926-54 [1]

Year	Plants	Man-hours worked	Number of injuries [2]					Number of days of disability [2]					Frequency rate [3]	Severity rate [3]
			F.	P. T.	P. P.	Temp.	Total	F.	P. T.	P. P.	Temp.	Total		
1926	43	5,816,909	3	—	6	241	250	18,000	—	9,000	4,772	31,772	42.978	5.462
1927	50	8,195,240	10	—	3	472	485	60,000	—	2,400	7,254	69,654	59.181	8.499
1928	58	8,051,291	9	—	5	390	404	54,000	—	9,000	6,381	69,381	50.178	8.617
1929	57	8,635,845	5	—	6	316	327	30,000	—	6,060	6,150	42,210	37.865	4.888
1930	74	8,608,782	7	—	10	242	259	42,000	—	7,475	4,139	53,614	30.086	6.228
1931	61	5,430,962	4	—	13	202	219	24,000	—	18,660	3,687	46,347	40.324	8.534
1932	42	2,820,300	1	—	4	81	86	6,000	—	6,750	2,646	15,396	30.493	5.459
1933	43	2,934,252	1	—	1	78	80	6,000	—	48	3,242	9,290	27.264	3.166
1934	50	3,536,403	1	—	2	119	122	6,000	—	2,850	2,160	11,010	34.498	3.113
1935	48	4,342,300	2	1	8	80	91	12,000	6,000	9,900	3,264	31,164	20.957	7.177
1936	54	6,733,770	6	—	14	189	209	36,000	—	8,168	4,707	48,875	31.038	7.258
1937	50	6,563,681	7	—	9	139	155	42,000	—	5,875	4,552	52,427	23.615	7.987
1938	50	4,992,561	2	—	6	78	86	12,000	—	6,600	3,317	21,917	17.226	4.390
1939	48	4,612,125	2	—	3	58	63	12,000	—	5,400	2,135	19,535	13.660	4.236
1940	50	4,734,396	1	—	6	86	93	6,000	—	7,050	3,901	16,951	19.643	3.580
1941	51	6,369,155	3	—	6	113	122	18,000	—	10,050	2,435	30,485	19.155	4.786
1942	52	7,964,829	3	2	2	216	223	18,000	12,000	3,300	5,452	38,752	27.998	4.865
1943	39	5,770,085	4	—	8	179	191	24,000	—	12,096	4,985	41,081	33.102	7.120
1944	36	4,723,929	4	—	5	145	154	24,000	—	5,400	4,119	33,519	32.600	7.096
1945	53	7,325,882	—	—	3	157	160	—	—	3,750	4,260	8,010	21.840	1.093
1946	54	8,630,738	3	—	8	228	239	18,000	—	5,816	5,175	28,991	27.692	3.359
1947	50	8,262,952	10	—	6	226	242	60,000	—	6,975	6,578	73,553	29.287	8.902
1948	51	7,893,600	4	—	11	197	212	24,000	—	8,018	5,577	37,595	26.857	4.763
1949	62	8,148,336	3	—	12	170	185	18,000	—	10,365	3,812	32,177	22.704	3.949
1950	51	7,612,446	3	—	8	178	189	18,000	—	6,854	4,635	29,489	24.828	3.874
1951	42	6,620,762	1	—	5	121	127	6,000	—	7,450	3,199	16,649	19.182	2.515
1952	42	6,417,298	3	—	3	130	136	18,000	—	1,674	2,879	22,553	21.193	3.514
1953	53	7,815,856	—	—	9	126	135	—	—	14,892	3,369	18,261	17.273	2.336
1954	67	6,795,590	2	—	9	104	115	12,000	—	6,905	3,026	21,931	16.923	3.227
Total	—	186,360,275	104	3	191	5,061	5,359	624,000	18,000	208,781	121,808	972,589	28.756	5.219

[1] As reports from mining companies are considered confidential by the Bureau of Mines, the identities of the operations to which this table relates are not revealed
[2] F., fatal; P. T., permanent total disability; P. P., permanent partial disability; Temp., temporary disability
[3] Frequency rate indicates the number of fatal, permanent, and other disabling injuries per million man-hours of exposure; severity rate indicates the number of days of disability lost from injuries per thousand man-hours of exposure

TABLE VI

NUMBER OF INJURIES, BY CLASSIFICATIONS, AT QUARRIES AND UNDERGROUND MINES IN THE NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION IN 1954

Classifications	Fatal	Permanent		Tempo-rary	Total
		Total	Partial		
Falls and slides of rock or materials	—	—	—	3	3
Handling materials or objects	—	—	—	21	21
Hand tools	—	—	—	5	5
Explosives	—	—	—	—	—
Haulage	—	—	1	7	8
Falls of persons	—	—	—	12	12
Bumping against objects	—	—	—	10	10
Falling objects	1	—	1	12	14
Flying objects	—	—	2	4	6
Electricity	—	—	—	1	1
Drilling	—	—	—	2	2
Machinery	1	—	5	4	10
Stepping on objects	—	—	—	5	5
Burns	—	—	—	4	4
Other causes	—	—	—	3	3
Total	2	—	9	93	104
Not stated	—	—	—	11	11
Grand total	2	—	9	104	115

TABLE VII

DAYS OF DISABILITY, BY CLASSIFICATIONS, OF INJURIES AT QUARRIES AND UNDERGROUND MINES IN THE NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION IN 1954

Classifications	Fatal	Permanent		Tempo-rary	Total
		Total	Partial		
Falls and slides of rock or materials	—	—	—	141	141
Handling materials or objects	—	—	—	488	488
Hand tools	—	—	—	142	142
Explosives	—	—	—	—	—
Haulage	—	—	240	374	614
Falls of persons	—	—	—	320	320
Bumping against objects	—	—	—	357	357
Falling objects	6,000	—	250	447	6,697
Flying objects	—	—	3,600	13	3,613
Electricity	—	—	—	1	1
Drilling	—	—	—	97	97
Machinery	6,000	—	2,815	314	9,129
Stepping on objects	—	—	—	29	29
Burns	—	—	—	81	81
Other causes	—	—	—	18	18
Total	12,000	—	6,905	2,822	21,727
Not stated	—	—	—	204	204
Grand total	12,000	—	6,905	3,026	21,931

TABLE VIII

NUMBER AND PERCENTAGE DISTRIBUTION OF INJURIES AT PLANTS ENROLLED IN THE NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION 1952–54, BY CLASSIFICATIONS

Classifications	1952		1953		1954		Total	
	Number	Per cent of total	Number	Per cent of total	Number	Per cent of total	Number	Per cent of total
Falls and slides of rock	16	13.1	9	6.8	3	2.9	28	7.8
Handling materials	17	13.9	33	24.8	21	20.2	71	19.8
Hand tools	5	4.1	4	3.0	5	4.8	14	3.9
Explosives	—	—	1	.7	—	—	1	.3
Haulage	11	9.0	16	12.0	8	7.7	35	9.8
Falls of persons	19	15.6	19	14.3	12	11.5	50	13.9
Bumping against objects	4	3.3	6	4.5	10	9.6	20	5.6
Falling objects	14	11.5	7	5.3	14	13.5	35	9.8
Flying objects	10	8.2	11	8.3	6	5.8	27	7.5
Electricity	4	3.3	2	1.5	1	1.0	7	1.9
Drilling	1	.8	2	1.5	2	1.9	5	1.4
Machinery	10	8.2	7	5.3	10	9.6	27	7.5
Stepping on objects	6	4.9	9	6.8	5	4.8	20	5.6
Burns	2	1.6	2	1.5	4	3.8	8	2.2
Other causes	3	2.5	5	3.7	3	2.9	11	3.0
Total	122	100.0	133	100.0	104	100.0	359	100.0
Causes not stated	14	—	2	—	11	—	27	—
Grand total	136	—	135	—	115	—	386	—

Statistics of the Competition

Over-all injury experience at the 67 operations enrolled in the 1954 competition was better than the average for the 29 years of the contest. The injury-frequency rate of 16.923 injuries per million man-hours was the second lowest annual rate, 41 per cent lower than the 29-year average, and slightly better than the 1953 rate. The severity rate of 3.227 days per thousand man-hours was the sixth lowest annual rate, 38 per cent lower than the 29-year average, but it was 38 per cent higher than the previous year's rate.

Man-hours of worktime at the competing plants totaled 6,795,590—5,880,228 at the 55 quarries and 915,362 at the 12 underground mines. During this volume of worktime accidents caused 115 lost-time injuries of which 2 were fatalities, 9 partial permanent, and 104 temporary total injuries.

TABLE IX

NUMBER AND PERCENTAGE DISTRIBUTION OF DAYS OF DISABILITY FROM INJURIES AT PLANTS ENROLLED IN THE NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION, 1952–54, BY CLASSIFICATIONS

Classifications	1952		1953		1954		Total	
	Days of disability	Per cent of total	Days of disability	Per cent of total	Days of disability	Per cent of total	Days of disability	Per cent of total
Falls and slides of rock	6,688	30.1	963	5.3	141	.7	7,792	12.5
Handling materials	259	1.2	659	3.6	488	2.2	1,406	2.3
Hand tools	29	.1	59	.3	142	.7	230	.4
Explosives	—	—	1,800	9.9	—	—	1,800	2.9
Haulage	6,152	27.7	896	4.9	614	2.8	7,662	12.3
Falls of persons	6,384	28.7	454	2.5	320	1.5	7,158	11.5
Bumping against objects	122	.5	103	.6	357	1.6	582	.9
Falling objects	281	1.3	1,683	9.3	6,697	30.8	8,661	13.9
Flying objects	59	.3	1,975	10.9	3,613	16.6	5,647	9.1
Electricity	17	.1	23	.1	1	[1]	41	.1
Drilling	16	.1	62	.3	97	.5	175	.3
Machinery	1,903	8.6	9,356	51.5	9,129	42.0	20,388	32.8
Stepping on objects	204	.9	51	.3	29	.1	284	.5
Burns	65	.3	15	.1	81	.4	161	.3
Other causes	22	.1	67	.4	18	.1	107	.2
Total	22,201	100.0	18,166	100.0	21,727	100.0	62,094	100.0
Causes not stated	352	—	95	—	204	—	651	—
Grand total	22,553	—	18,261	—	21,931	—	62,745	—

[1] Less than 0.05 per cent

TABLE X

EMPLOYMENT AND INJURY DATA FOR CRUSHED STONE PLANTS ENROLLED IN THE NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION, 1953 AND 1954, COVERING IDENTICAL PLANTS FOR BOTH YEARS AND PLANTS ENROLLED ONLY IN 1953 OR IN 1954 [1]

	No.	Man-hours worked	Number of injuries [2]					Days of disability [2]					Frequency rate [3]	Severity rate [3]
			F.	P.T.	P.P.	Temp.	Total	F.	P.T.	P.P.	Temp.	Total		
Plants enrolled in 1953 only	9	1,132,210	—	—	2	25	27	—	—	1,542	504	2,046	23.847	1.807
Identical plants enrolled both years, 1953	47	6,913,577	—	—	7	101	108	—	—	13,350	2,865	16,215	15.621	2.345
Identical plants enrolled both years, 1954	47	5,652,316	2	—	6	83	91	12,000	—	2,990	2,355	17,345	16.100	3.069
Plants enrolled in 1954 only	20	1,143,274	—	—	3	21	24	—	—	3,915	671	4,586	20.992	4.011

[1] As reports from mining companies are considered confidential by the Bureau of Mines, the identities of the operations to which this table relates are not revealed
[2] F., fatal; P.T., permanent total disability; P.P., permanent partial disability; Temp., temporary disability
[3] Frequency rate indicates the number of fatal, permanent, and other disabling injuries per million man-hours of exposure; severity rate indicates the number of days of disability lost from injuries per thousand man-hours of exposure

Of the 67 plants enrolled in the 1954 competition, 55 were open quarries and 12 were underground mines, the latter a record enrollment. The injury-frequency rate (17.856) at open quarries was the next lowest rate on record. The severity rate (2.581) while almost double that of the 29-year average continued on improved trend from 1948 when this rate was 5.272.

At the 12 underground mines enrolled in the 1954 competition, the injury frequency of 10.925 was slightly higher than the corresponding 1953 rate; however, it was the fourth best rate on record, bet-

(*Continued on page 22*)

TABLE XI

AVERAGE DAYS OF DISABILITY PER TEMPORARY INJURY AT PLANTS ENROLLED IN THE NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION

Year	Underground mines			Open quarries			Total		
	Number of temporary injuries	Number of days of disability	Average days of disability	Number of temporary injuries	Number of days of disability	Average days of disability	Number of temporary injuries	Number of days of disability	Average days of disability
1926	34	533	16	207	4,239	20	241	4,772	20
1927	14	68	5	458	7,186	16	472	7,254	15
1928	68	888	13	322	5,493	17	390	6,381	16
1929	30	617	21	286	5,533	19	316	6,150	19
1930	15	468	31	227	3,671	16	242	4,139	17
1931	4	147	37	198	3,540	18	202	3,687	18
1932	6	165	28	75	2,481	33	81	2,646	33
1933	11	349	32	67	2,893	43	78	3,242	42
1934	13	287	22	106	1,873	18	119	2,160	18
1935	3	249	83	77	3,015	39	80	3,264	41
1936	7	117	17	182	4,590	25	189	4,707	25
1937	3	91	30	136	4,461	33	139	4,552	33
1938	2	133	67	76	3,184	42	78	3,317	43
1939	7	457	65	51	1,678	33	58	2,135	37
1940	8	888	111	78	3,013	39	86	3,901	45
1941	15	169	11	98	2,266	23	113	2,435	22
1942	33	1,213	37	183	4,239	23	216	5,452	25
1943	45	1,123	25	134	3,862	29	179	4,985	28
1944	27	796	29	118	3,323	28	145	4,119	28
1945	22	755	34	135	3,505	26	157	4,260	27
1946	31	1,045	34	197	4,130	21	228	5,175	23
1947	29	1,588	55	197	4,990	25	226	6,578	29
1948	16	935	58	181	4,642	26	197	5,577	28
1949	17	467	27	153	3,345	22	170	3,812	22
1950	25	810	32	153	3,825	25	178	4,635	26
1951	21	818	39	100	2,381	24	121	3,199	26
1952	19	583	31	111	2,296	21	130	2,879	22
1953	12	487	41	114	2,882	25	126	3,369	27
1954	9	754	84	95	2,272	24	104	3,026	29
Total	546	17,000	31	4,515	104,808	23	5,061	121,808	24

Program for NCSA Sixth Short Course for Crushed Stone Salesmen

SHERATON PARK HOTEL
WASHINGTON, D. C.
DECEMBER 6, 7, 8, and 9, 1955

ANNOUNCEMENT has already been made of the Sixth Short Course for Crushed Stone Salesmen to be given by the National Crushed Stone Association in Washington, on December 6, 7, 8, and 9. These dates were selected as being the most convenient for most of those who will attend. We have already received definite assurance of attendance by a large number of representatives of our member companies and arrangements have been made to reserve, at the Sheraton Park Hotel, a beautiful meeting room which will accommodate an audience of 300, if necessary.

The program is given here in preliminary form without announcing the names of the speakers. It will be noted that the first three days, Tuesday, Wednesday, and Thursday, December 6, 7, and 8, will be devoted to lecture sessions and the last day, Friday, will be spent at the NCSA laboratory where demonstrations will be made and exhibits set up to illustrate important phases of the testing procedures. Some of those in attendance may not be particularly interested in the laboratory work and this arrangement of the program will permit them to attend the lectures only, if they so desire. Those who are concerned with testing methods will wish to stay through Friday and spend the entire day with us at the laboratory.

Our lectures this year, unlike those in previous years, will be given at the Sheraton Park and, since this hotel is several miles from the downtown hotels, it undoubtedly will be the most convenient place to stay. Incidentally, the Sheraton Park has just been beautifully renovated and now it has one of the largest hotel auditoriums in this country.

Additional information will be mailed as it is developed.

PROGRAM

TUESDAY, DECEMBER 6

Morning

9:00—Registration
10:00—Welcome
10:10—Classification and Characteristics of Rocks Used for Construction
11:00—Discussion
11:10—Intermission
11:20—Laboratory Tests of Stone, Concrete, and Bituminous Concrete—Motion Picture
11:55—Discussion
12:00—Adjournment

Afternoon

2:00—The Sampling of Aggregates
2:30—Discussion
2:40—The Reasons for the Requirements in Aggregate Specifications
3:10—Discussion
3:20—Stone for Bituminous Surface Treatments
3:50—Discussion
4:00—Intermission
4:10—Shape of Particle, How Measured, Significance
4:40—Discussion
5:00—Adjournment

WEDNESDAY, DECEMBER 7

Morning

9:00—Elements of Rigid Pavement Design
9:40—Discussion
9:50—a. Waterbound Macadam
b. Stabilized Aggregate Base Course
10:30—Discussion
10:50—Intermission
11:00—Elements of Flexible Pavement Design
11:45—Discussion
12:00—Adjournment

Afternoon

2:00—Deleterious Materials in Aggregates
2:30—Discussion
2:40—Fire Resistance Tests on Concrete—Their Significance—The Rating of Aggregates for Fire Resistance
3:10—Discussion
3:20—Intermission
3:30—Penetration Macadam
4:10—Discussion

WEDNESDAY, DECEMBER 7

Afternoon (continued)

4:20—Some Problems in Bituminous Concrete—Their Cure
- Cracking During Rolling
- Shoving
- Stripping
- Effect of Temperature of Asphalt During Shipment
- Slipperiness

4:50—Discussion

5:00—Adjournment

THURSDAY, DECEMBER 8

Morning

9:00—The Proportioning of Bituminous Concrete

9:50—Discussion

10:00—The Proportioning of Portland Cement Concrete

10:50—Discussion

11:00—Intermission

11:10—Stone for Railroad Ballast

11:50—Discussion

12:00—Adjournment

Afternoon

2:00—Informal Discussion by Audience on Values of Crushed Stone for
- a. Portland Cement Concrete Pavement
- b. Structural Concrete
- c. Mass Concrete
- d. Concrete Block and Brick
- e. Bituminous Macadam
- f. Bituminous Concrete
- g. Bituminous Surface Treatment
- h. Pavement Base Courses
- i. Railroad Ballast
- j. Trickling Filters

4:30—Concluding Remarks

4:50—Discussion

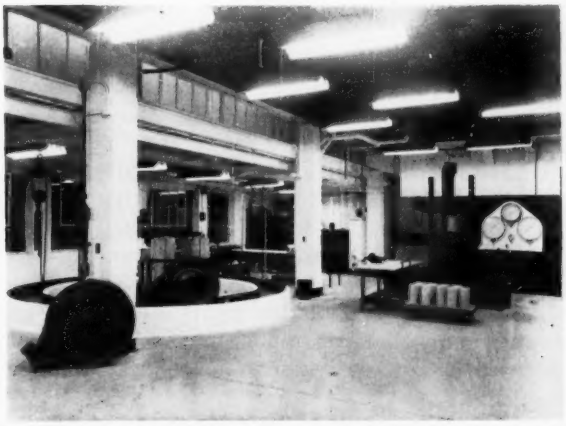
5:00—Adjournment

FRIDAY, DECEMBER 9

9:00 to 5:00

Demonstrations and Exhibits in the NCSA Laboratory for those having an interest in testing procedure. The laboratory is located at 1415 Elliot Place, N. W., near 4500 McArthur Boulevard.

NCSA Automatic Freezing-and-Thawing Apparatus



General View of NCSA Research Laboratory Showing 300,000 Pound Testing Machine and Circular Track for Bituminous Concrete Investigations

The Five Basic Issues in Highway Legislation

(*Continued from page 7*)

but it insures a balanced program by increasing the effort on the Primary and Secondary roads, as well. It retains an apportionment formula, insuring each state its fair share of federal funds. It is orthodox in its financial approach and it preserves Congressional control over the program and its administration.

Perhaps the most important single advantage in the Senate Bill is the fact that it is still alive and half-way through the Congress. The approach suggested by the Administration Bill has already been defeated in both Houses. It was defeated in the Senate by an overwhelming two-to-one vote. The House Committee Bill was voted down in the House by a two-to-one vote. Only the Senate highway bill remains alive, and it, as I have said, is already half-way to enactment.

I don't want to appear to be in a position of criticising those Members of Congress who supported the Administration Bill or those in the House who supported the bill recommended by the House Committee. I respect the sincerity of their views. I am sure they, just as you and I, want a highway bill. But we might as well be practical about it. The program contained in the Senate Bill is the one that hasn't been defeated.

I have heard some talk about a compromise that would take the form of "half a corporation and half not a corporation." I haven't seen such a suggestion written in bill form, but it is my sincere belief that any bill creating a Corporation with disguised deficit spending and hidden public debt, even if it involves only half as much money as originally proposed, will have little or no chance of passing the Senate.

As I said, I don't contend that the Senate Bill is perfect. I would not suggest that the House should accept it word for word. But if we are to have a highway bill next year, the Senate Bill is the most logical base upon which to build!

PLEASE NOTE

National Crushed Stone Association
Telephone Number changed to

FEDERAL 3-1536

NCSA Safety Competition

(*Continued from page 19*)

ter only in 1937, 1938, and 1953. The high severity rate of 7.379 per thousand man-hours was the result of a fatality, the first recorded for underground mines since 1950.

Type and Severity of Injuries

Accidents involving handling materials or objects were responsible for 21, or 20 per cent of all injuries for which causes were specifically reported. Falling objects resulted in 13 nonfatal injuries and 1 death, or 14 per cent; falls of persons injured 12, or 12 per cent; bumping against objects and machinery accidents, 10 each; haulage accidents, 8; and struck by flying object or objects, 6. Under these 7 categories, 81, or 79 per cent of all the injuries occurred. The most severe injuries were those involving machinery, falling objects, and flying objects. The total number of disability days under those three types of injuries amounted to 19,439 or over 89 per cent of the time lost because of all injuries.

The Competition

This safety competition among operations in the crushed stone industry is conducted by the Bureau of Mines under the same rules as the National Safety Competition. The same records are used in both contests. However, there are two additional requirements that must be established before a crushed stone operation may participate in this competition, namely: (1) it must have commercial production of crushed stone, and (2) it must be a member of the National Crushed Stone Association.

ARBA Issues Directory of Highway Officials

The American Road Builders' Association has available, in attractive and convenient pocket size, a Directory of Highway Officials and Engineers. This Directory shows the personnel as of June 1955 of State Highway Departments, State Toll Road Authorities, and the Bureau of Public Roads. It is available at $1.00 per copy upon request to the American Road Builders' Association, World Center Building, Washington 6, D. C.

Manufacturers Division — National Crushed Stone Association

These associate members are morally and financially aiding the Association in its efforts to protect and advance the interests of the crushed stone industry. Please give them favorable consideration whenever possible.

Allis-Chalmers Mfg. Co.
Milwaukee 1, Wis.
Crushing, Screening, Washing, Grinding, Cement Machinery; Motors; Texrope Drives; Centrifugal Pumps; Tractors

American Cyanamid Co.
Explosives Department
30 Rockefeller Plaza, New York 20, N. Y.
Explosives and Blasting Supplies

American Hoist & Derrick Co.
63 South Robert St., St. Paul 1, Minn.
Crawler and Truck Cranes, Shovels, Draglines, and Clamshells; Locomotive and Gantry Cranes; Hoists, Derricks, and Wire Rope Clips and Fittings

American Manganese Steel Division
American Brake Shoe Co.
109 North Wabash Ave., Chicago 2, Ill.
Manganese and Alloy Steel Castings, Power Shovel Dippers, Material Handling Pumps, Reclamation and Hard-Facing Welding Materials

American Pulverizer Co.
1249 Macklind Ave., St. Louis 10, Mo.
Manufacturers of Ring Crushers and Hammermills for Primary and Secondary Crushing

American Steel & Wire Division
Rockefeller Bldg., 614 Superior Ave., N. W., Cleveland 13, Ohio
Wire Rope, Aerial Wire Rope Tramways, Electrical Wires and Cables, Welded Wire Fabric, Concrete Reinforcing, Wire Nails, Fencing, Netting

Aquadyne Corp.
62 LaSalle Road, West Hartford, Conn.
"Wet Water" Dust Control System

Atlas Powder Co.
Wilmington 99, Del.
Industrial Explosives and Blasting Supplies

Bacon-Greene & Milroy
29 Washington Ave., Hamden 14, Conn.
"Farrel-Bacon" Jaw Crushers for Primary and Secondary Operations, Conveyors, Elevators, Rolls, Screens

Baker-Raulang Corp.
314 West 90th St., Minneapolis 20, Minn.
Shovel Loaders (Front End)

Baldwin-Lima-Hamilton Corp.
Construction Equipment Division
South Main St., Lima, Ohio
Power Shovels, Draglines, Cranes, Bins, Conveyors and Idlers, Crushers and Pulverizers, Feeders, Plants—Crushing and Portable, Washing Equipment

Barber-Greene Co.
400 North Highland Ave., Aurora, Ill.
Portable and Permanent Belt Conveyors, Belt Conveyor Idlers, Bucket Loaders Both Wheel and Crawler Mounted, Asphalt Mixers and Finishers, Coal Handling Machines

Birdsboro-Buchanan Crusher Dept.
Birdsboro Steel Foundry & Machine Co.
1941 Furnace St., Birdsboro, Pa.
Primary and Secondary Crushers and Rolls

Boston Woven Hose & Rubber Co.
P. O. Box 1071, Boston 3, Mass.
Conveyor, Elevator, and Transmission Belt; V-Belts; Air Hoses; Suction Hose

Brunner & Lay Rock Bit of Asheville, Inc.
P. O. Box 5235, Asheville, N. C.
Tungsten Carbide Detachable Bits, "Rock Bit" Drill Steel Inlaid with Tungsten Carbide, Carbon Hollow Drill Steel, Alloy Hollow Drill Steel

Bucyrus-Erie Co.
South Milwaukee, Wis.
Excavating, Drilling, and Material Handling Equipment

Buda Division
Allis-Chalmers Mfg. Co.
Harvey, Ill.
Diesel and Gasoline Engines; Material Handling Equipment; Lifting Jacks; Earth Drills and Maintenance of Way Equipment

Burress, J. W.
1701 Shenandoah Ave., N. W., Roanoke, Va.
"Air-Trac" Drill Carrier

Cape Ann Anchor & Forge Co.
P.O. Box 360, Gloucester, Mass.
"Cape Ann" Forged Steel Drop Balls

Caterpillar Tractor Co.
Peoria 8, Ill.
Track-Type Tractors, Bulldozers, Earthmoving Scrapers, Motor Graders, Heavy-Duty Off-Road Hauling Units, Diesel Engines, Diesel Electric Generating Sets, Front End Shovels, Wheel-Type Tractors

Manufacturers Division—National Crushed Stone Association
(continued)

Chain Belt Co.
P. O. Box 2022, Milwaukee 1, Wis.
Rex Conveyors, Elevators, Feeders, Idlers, Elevator Buckets, Drive and Conveyor Chains, Sprockets, Bearings, Pillow Blocks, Power Transmission Equipment, Portable Self-Priming Pumps

Clark Equipment Co.
Construction Machinery Division
300 Miller St., Benton Harbor, Mich.
Truck and Crawler Excavator Cranes—3/8, 1/2, 3/4 Cu. Yd.; Tractor Shovels—15 Cu. Ft. Through 2 1/4 Cu. Yd.

Cleveland Rock Drill Division
Westinghouse Air Brake Co.
12500 Berea Road, Cleveland 11, Ohio
Rock and Wagon Drills; Jumbo Drill Rigs, Drifters, Stopers, Self Propelled Drill Rigs

Continental Gin Co.
4500 Fifth Ave., S., Birmingham 2, Ala.
Conveyors—Belt, Screw, Flight and Underground Mine; Elevators—Bucket and Screw; Feeders—Apron, Belt, Reciprocating, Table, and Screw; Drives—V-Belts. Chains and Sprockets, Gears and Speed Reducers

Contractors and Engineers
470 Fourth Ave., New York 16, N. Y.
Magazine of Modern Construction

Cross Engineering Co.
P. O. Box 507, Carbondale, Pa.
Cross Perforated Steel Segments, Sections, Decks, for Vibrating, Shaking, Revolving, and Other Types of Screening Equipment

Cummins Engine Co., Inc.
Fifth and Union Sts., Columbus, Ind.
Lightweight Highspeed Diesel Engines (60-600 Hp.) for: On-Highway Trucks. Off-Highway Trucks, Buses, Tractors, Earthmovers, Shovels, Cranes, Industrial and Switcher Locomotives, Air Compressors, Logging Yarders and Loaders, Oil Well Drilling Rigs, Centrifugal Pumps, Generator Sets and Power Units, Work Boats and Pleasure Craft

Dart Truck Co.
2623 Oak St., Kansas City 8, Mo.
Off Highway Trucks—End, Side, Bottom Dumps

Deister Machine Co.
1933 East Wayne St., Fort Wayne 4, Ind.
Deister Vibrating Screens, Classifiers, Washing Equipment

Detroit Diesel Engine Division
General Motors Corp.
13400 West Outer Drive, Detroit 28, Mich.
Light Weight, Compact 2 Cycle Diesel Engines and "Package Power" Units for All Classes of Service

Diamond Iron Works
Division Goodman Manufacturing Co.
Halsted Street & 48th Place, Chicago 9, Ill.
Jaw and Roll Crushers; Vibrator, Revolving, and Scrubber Screens; Drag Washers; Bucket Elevators; Belt Conveyors; Bins; Apron and Plate Feeders; Portable Gravel and Rock Crushing, Screening, and Washing Plants; Stationary Crushing, Screening, and Washing Plants; Hammermills

Du Pont, E. I., de Nemours & Co.
Wilmington 98, Del.
Explosives and Blasting Supplies

Dustex Corp.
1758 Walden Ave., Buffalo 25, N. Y.
Dust Collecting Equipment; Dust Control Systems

Eagle Crusher Co., Inc.
900 Harding Way East, Galion, Ohio
Crushers

Eagle Iron Works
129 Holcomb Ave., Des Moines 13, Iowa
Fine Material Screw Washers—Classifiers—Dehydrators; Coarse Material Screw and Log Washers—Dewaterers; Water Scalping and Fine Material Settling Tanks; Drop Balls—Ni-Hard and Semi-Steel; "Swintek" Screen Chain Cutter Dredging Ladders

Easton Car & Construction Co.
Easton, Pa.
Off-Highway Transportation: Dump Trailers, Truck Bodies, and Cars for Mines, Quarries, and Earth Moving Projects

Ensign-Bickford Co.
Simsbury, Conn.
Primacord-Bickford Detonating Fuse and Safety Fuse

Euclid Division
General Motors Corp.
1361 Chardon Road, Cleveland 17, Ohio
Heavy-Duty Trucks and Dump Trailers for "Off-Highway" Hauls. Loaders for Earth Excavation, Single and Twin Engine Earth Moving Scrapers

Frog, Switch & Mfg. Co.
Manganese Steel Dept.
Carlisle, Pa.
Manufacturers of "Indian Brand" Manganese Steel Castings for all Types of Jaw, Gyratory, and Pulverizing Crushers; Dippers, Teeth, Treads, and Other Parts for Power Excavating Equipment; and Other Miscellaneous Manganese Steel Castings. Manufacturers and Fabricators of Railroad and Mine Frogs, Switches, and Crossings

Manufacturers Division—National Crushed Stone Association
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1 River Road, Schenectady 5, N. Y.
Electric Motors, Controls, Locomotives, Welding Equipment, Coordinated Electric Drives for: Shovels, Drag Lines, Conveyors, Hoists, Cranes, Crushers, Screens, Etc.; Coordinated Power Generating and Distributing Systems Including Generators, Switchgear, Transformers, Cable, Cable Skids, Load Center Substations

Gill Rock Drill Co.
Lebanon, Pa.
Well Drill Tools and Supplies

Goodyear Tire & Rubber Co., Inc.
Akron 16, Ohio
Airfoam; Industrial Rubber Products—Belting (Conveyor, Elevator, Transmission), Hose (Air, Water, Steam, Suction, Miscellaneous); Chute Lining (Rubber); Rims (Truck and Tractor); Storage Batteries (Automobile, Truck, Tractor); Tires (Automobile, Truck, Off-the-Road); Tubes (Automobile, Truck, Off-the-Road, Life-Guard, Safety Tubes, Puncture Seal Tubes)

Gruendler Crusher and Pulverizer Co.
2915 North Market St., St. Louis 6, Mo.
Rock and Gravel Crushing, Screening and Washing Plants, Jaw Crushers, Roll Crushers, Hammermills, Lime Pulverizers

Gulf Oil Corp.
Gulf Refining Co.
Gulf Bldg., Pittsburgh 19, Pa.
Lubricating Oils, Greases, Gasoline and Diesel Fuels

Haiss, George, Mfg. Co., Inc.
Division of Pettibone Mulliken Corp.
5720 Empire State Bldg., New York 1, N. Y.
Bucket Loaders, Buckets, Portable and Stationary Conveyors, Car Unloaders

Harnischfeger Corp.
4400 West National Ave., Milwaukee 14, Wis.
A Complete Line of Power Excavating Equipment, Overhead Cranes, Hoists, Smootharc Welders, Welding Rod, Motors and Generators, Diesel Engines

HarriSteel Products Co.
420 Lexington Ave., New York 17, N. Y.
Woven Wire Screen Cloth

Hayward Co.
50 Church St., New York 7, N. Y.
Orange Peel Buckets, Clam Shell Buckets, Electric Motor Buckets, Automatic Take-up Reels

Heidenreich, E. Lee, Jr.
Consulting Engineers
75 Second St., Newburgh, N. Y.
Plant Layout, Design, Supervision; Open Pit Quarry Surveys; Appraisals—Plant and Property

Hendrick Mfg. Co.
Carbondale, Pa.
Perforated Metal Screens, Perforated Plates for Vibrating, Shaking, and Revolving Screens; Elevator Buckets; Test Screens; Wedge Slot Screens; Open Steel Floor Grating

Hercules Powder Co.
Wilmington 99, Del.
Explosives and Blasting Supplies

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Asphalt Paving Machinery, Sand and Stone Dryers

Hewitt-Robins Incorporated
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Abraso St., P. O. Box 22, Lancaster, Pa.
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Hughes Tool Co.
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Bits—Rock

Illincis Powder Mfg. Co.
506 Olive St., St. Louis 1, Mo.
Gold Medal Explosives

Ingersoll-Rand Co.
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Rock Drills, Paving Breakers, Paving Breaker Tools and Accessories, Quarrymaster Drills, Drillmasters, Carset Bits, Jackbits, Bit Reconditioning Equipment, Portable and Stationary Air Compressors, Air Hoists, Slusher Hoists, Pneumatic Tools, Centrifugal Pumps, Diesel and Gas Engines

Insley Manufacturing Corp.
801 North Olney St., Indianapolis 6, Ind.
Concrete Carts and Buckets; 1/2 to 2 Cu. Yd. Cranes and Shovels—5 to 30 Tons Capacity—Rubber or Crawler Mounting

International Harvester Co.
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Trucks, Trailers, Truck Bodies, Highway Trucks, Truck Bodies Off-Highway

Manufacturers Division—National Crushed Stone Association

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Jeffrey Manufacturing Co.

East First Ave., Columbus 16, Ohio

Elevator Buckets; Car Pullers; Chains; Conveyors: Belt, Drag, Apron, Vibrating; Idlers; Crushers; Pulverizers; Elevators; Feeders; Pillow Blocks; Stationary Plants; Screens

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Joy Manufacturing Co.

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Kennedy-Van Saun Mfg. & Eng. Corp.

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Cincinnati, Ohio

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Primary and Secondary Rock Crushers and Auxiliary Equipment such as Feeders, Screens, Conveyors, Etc., Portable and Stationary Crushing and Washing Plants

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Manufacturers Division—National Crushed Stone Association

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Multi-Wall Paper Bag Division

Jaite, Ohio

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New York Rubber Corp.

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Nordberg Mfg. Co.

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Northern Blower Co.

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Northwest Engineering Co.

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Shovels, Cranes, Draglines, Pullshovels—Crawler and Truck Mounted

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Single Roll Crushers, Impactors, Hammermills, Ring Type Granulators, Kue-Ken Jaw Crushers, Kue-Ken Gyratories, Dixie Non-Clog and Standard Hammermills

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4710 West Division St., Chicago 51, Ill.

Material Handling Buckets, Clamshells, Draglines, Pullshovels, Dippers, Shovel Dippers, Pumps, Hammermills, Front End Loaders, Bucket Conveyor Loaders, Fork and Bucket Loaders, Speed Swing Loaders, Speed Swing Yard Cranes, Motor Graders, Manganese Steel Castings

Pioneer Engineering Works, Inc.

1515 Central Ave., N. E., Minneapolis 13, Minn.

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Pit and Quarry Publications, Inc.

431 South Dearborn St., Chicago 5, Ill.

Pit and Quarry, Pit and Quarry Handbook, Pit and Quarry Directory, Concrete Manufacturer, Concrete Industries Yearbook

Productive Equipment Corp.

2926 West Lake St., Chicago 12, Ill.

Vibrating Screens

Quaker Rubber Corp.
Division of H. K. Porter Co., Inc.
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Tacony and Milnor Sts., Philadelphia 24, Pa.

Conveyor Belts, Hose, and Packing

Radio Corporation of America
Engineering Products Department
Industrial Equipment Section

Front and Cooper Sts., Bldg. 15-1, Camden 2, N. J.

Electronic Metal Detectors

Rock Products and Concrete Products

309 West Jackson Blvd., Chicago 6, Ill.

Rogers Iron Works Co.

11th and Pearl Sts., Joplin, Mo.

Jaw Crushers, Roll Crushers, Hammermills, Vibrating Screens, Revolving Screens and Scrubbers, Apron Feeders, Reciprocating Feeders, Roll Grizzlys, Conveyors, Elevators, Portable and Stationary Crushing and Screening Plants, Mine Hoists, Drill Jumbos and Underground Loaders

Screen Equipment Co., Inc.

1754 Walden Ave., Buffalo 25, N. Y.

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Simplicity Engineering Co.

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Manufacturers Division—National Crushed Stone Association
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Gyratory, Gyrasphere, Jaw and Roll Crushers; Vibrating and Rotary Screens, Gravel Washing and Sand Settling Equipment, Elevators and Conveyors, Feeders, Bin Gates, and Portable Crushing and Screening Plants

Stedman Foundry & Machine Co., Inc.

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Stedman Impact-Type Selective Reduction Crushers, 2-Stage Swing Hammer Limestone Pulverizers, Multi-Cage Limestone Pulverizers, Vibrating Screens

Stephens-Adamson Mfg. Co.

Aurora, Ill.

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Manganese and other Special Alloy Steel and Iron Castings; Dipper Teeth, Fronts and Lips; Crawler Treads; Jaw and Cheek Plates; Mantles and Concaves; Pulverizer Hammers and Liners; Asphalt Mixer Liners and Tips; Manganese Nickel Steel Welding Rod and Plate

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1/2 and 3/4 Cu. Yd. Crawler, Mobile and Truck Mounted Shovels, Draglines, Cranes, Clamshells, Trenchoes, and Magnets

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No. 1. How to Proportion Workable Concrete for Any Desired Compressive Strength

No. 2. How to Proportion Concrete for Pavements

No. 3. Uses for Stone Screenings

No. 4. How to Determine the Required Thickness of the Non-Rigid Type of Pavement for Highways and Airport Runways

No. 5. The Insulation Base Course Under Portland Cement Concrete Pavements

ENGINEERING BULLETINS

No. 1. The Bulking of Sand and Its Effect on Concrete

No. 2. Low Cost Improvement of Earth Roads with Crushed Stone

No. 4. "Retreading" Our Highways

No. 5. Reprint of "Comparative Tests of Crushed Stone and Gravel Concrete in New Jersey" with Discussion

No. 7. Investigations in the Proportioning of Concrete for Highways

No. 9. Tests for the Traffic Durability of Bituminous Pavements

No. 11. A Method of Proportioning Concrete for Strength, Workability, and Durability. **(Revised November 1953)**

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